SOUTHERN INSECT MANAGEMENT LABORATORY

USDA/ARS
Stoneville, Mississippi

Annual Report on Progress (CY 1990) and Plans (CY 1991)

CONTENTS

I. Introduction

This report summarizes progress made on various research objectives in 1990 and presents plans for 1991.

Many of the results are preliminary and others are being released through established channels. Therefore, this report is not intended for publication and should not be referred to in literature citations.

The intent of this report is to give the reader an overview of Southern Insect Management Laboratory (SIML) research activities. These activities (progress and plans) address the laboratory and unit missions (listed on pages 4-7). To accomplish the mission, the Laboratory is divided into one unit at Stoneville (Southern Insect Management Research Unit (SIMRU)) and one unit at Mississippi State (Insect Rearing Research Unit (IRRU)) which is housed in the R. T. Gast Rearing Laboratory.

SIML activities are centered around six research thrusts, which reflect present CRIS work units. These are:

(1) Biological and genetic control of crop insect pests, emphasizing Heliothis/Helicoverpa;

(2) Population ecology of insect pests for integrated control/ management systems;

(3) Biology, ecology, and behavior of plant bugs and cotton aphids;

(4) Strategies for managing crop insects, emphasizing the cotton agroecosystem and pesticide application technology;

(5) Integrated control of pecan pests; and

(6) Mass propagation technology for the boll weevil, Heliothis/Helicoverpa, and Microplitis croceipes (Cresson).

The first through fifth areas are researched by SIMR Unit and the sixth by the IRR Unit.

This report is divided into four sections:

(1) Report on research progress in CY 1990;

(2) List of publications including those in press and accepted for publication;

(3) Other indicators of progress such as presentations and papers in manuscript; and

(4) Plans for CY 1991.

In each section, items are arranged by researcher (in alphabetical order of lead scientist; the name of lead scientist and cooperating and/or collaborating researchers are provided for each item). If the reader has questions pertaining to the item, he/she should contact the individual scientist, research leader, or laboratory director.

II. Mission Statement and Staff

SOUTHERN INSECT MANAGEMENT LABORATORY
ARS/USDA, Mid South Area
Stoneville, Mississippi 38776
Telephone: Comm. 601-686-5231
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OFFICE OF LABORATORY DIRECTOR

Mission:

The mission of the Southern Insect Management Laboratory is to conduct fundamental research on the biology, ecology, and rearing of field crop and pecan insect pests and their natural enemies; develop innovative biological, genetic, cultural, and chemical methods for suppressing insect pests; and integrate this knowledge into insect management systems. A goal of this laboratory is to develop new and improved insect pest suppression strategies, including improvements in pesticide application technology, for population management approaches to improve crop production efficiency. Exotic organisms are received and cleared through the Stoneville Research Quarantine Facility for biological control of insects and weeds. Exotic predators and parasites are released and evaluated for establishment on field crop insect pests.

ARS PERSONNEL:

D. D. Hardee, Laboratory Director
T. G. Burton, Secretary
L. E. Taylor, Clerk Typist
G. G. Hartley, Entomologist (Insect Rearing)
H. E. Winters, Biological Technician (Insect Rearing)
W. W. Harrison, Quarantine Officer
J. D. Warren, Instrument Maker (Shop)

SOUTHERN INSECT MANAGEMENT RESEARCH UNIT

Mission:

To develop new knowledge on the biology of field crop insects for development of new and improved control principles and to establish fundamental principles for encouraging and using natural enemies more effectively. To develop and integrate insect suppression strategies into field crop and pecan systems that minimize the cost of plant protection yet are ecologically acceptable. Specifically:

1. Elucidate the efficacy of indigenous predators and parasites, particularly those attacking the bollworm, Helicoverpa zea, and tobacco budworm, Heliothis virescens.

2. Research and develop methods for augmenting parasite populations to manage insect pests of field crops, particularly use of Microplitis croceipes for control of Heliothis/Helicoverpa.

3. Develop new knowledge on biology and behavior of Heliothis/Helicoverpa spp., initially emphasizing genetic characterization of Helicoverpa for establishment of a bollworm sterile hybrid.

4. Conduct basic biological and ecological research on plant bugs, particularly the tarnished plant bug, Lygus lineolaris, and aphids, particularly the cotton aphid, Aphis gossypii.

5. Develop monitoring and predictive technology through quantitative population ecology for field crop insect pests, particularly bollworm/budworm and tarnished plant bug; conduct systems analyses and develop models for evaluation of suppression strategies.

6. Assess the role of early season host plants in the buildup of Heliothis/Helicoverpa and tarnished plant bug populations and devise new and innovative tactics for suppressing these populations.

7. Develop chemical/biorational control tactics for use in integrated systems.

8. Develop chemical, biological, and other nonchemical methods for control of insect and mite pests of pecans. Evaluate selections and native pecans for yield and adaptability to the mid-south U.S.

9. Research potential improvements in pesticide application technology in cooperation with agricultural engineers.

ARS PERSONNEL:

D. D. Hardee, Research Leader, Laboratory Director
(Supervisory Research Entomologist)
J. M. Ainsworth, Biological Technician
K. E. Ward, Ecologist (Research Associate)

M. R. Bell, Research Entomologist
R. A. Drake, Biological Technician

Vacancy, Research Entomologist
R. W. Hoagland, Biological Technician

G. W. Elzen, Research Entomologist
L. C. Adams, Biological Technician

D. E. Hendricks, Research Entomologist
D. W. Hubbard, Biological Technician

L. Lambert, Research Entomologist
Vacancy, Biological Technician

M. L. Laster, Research Entomologist
S. B. Ginn, Biological Technician

J. E. Powell, Research Entomologist
F. M. Williams, Biological Technician

W. P. Scott, Research Entomologist
D. A. Adams, Biological Technician

G. L. Snodgrass, Research Entomologist
Vacancy, Biological Technician

INSECT REARING RESEARCH UNIT

Mission:

the goal of this management unit, located at Mississippi State, Mississippi, is to develop science and technology of mass propagation, storage, transfer, and release of cotton insects emphasizing the boll weevil, Heliothis, and parasitoid, Microplitis croceipes (Cresson). Specifically:

1. Research is directed toward establishment of a cost effective propagation program capable of producing the quantity and quality of insects required to support field evaluation needs.

2. Initial research emphasis is placed on boll weevil production, automation of Heliothis/Helicoverpa and Microplitis rearing, establishment of quality control standards, establishment of standards for shipping and releasing insects, and evaluation of new rearing methods.

ARS PERSONNEL:

D. D. Hardee, Research Entomologist
(Supervisory Research Entomologist)

J. L. Roberson, Supervisory Entomologist
T. L. Blair, Insect Production Worker
E. M. Griffin, Biological Technician
D. K. Harsh, Engineering Technician
O. L. Malone, Biological Laboratory Technician
G. G. McCain, Secretary
C. Tate, Insect Production Worker
M. Tate, Insect Production Worker

III. Summary of Research Progress for Calendar Year 1990

A Narrative

1. In-House

A pilot test was conducted in the spring of 1990 in which 1,653 lbs of the nuclear polyhedrosis virus from the cotton bollworm (ELCAR) was aerially applied to all plants within an area of 100 square miles (64,000 ac) when the bollworm/budworm larvae were developing on early-season alternate hosts. Emerging adult populations were compared to a similar control area, separated by a 10-mi buffer, and to an untreated area immediately surrounding the treated area (an additional 300 square miles). Spray coverage, amount and persistence of the virus on the alternate host plants, and the number and species of moths emerging from alternate hosts within the test areas were recorded. Based on pheromone trap data, the treated area produced 38% fewer tobacco budworms, Heliothis virescens, and 31% fewer cotton bollworms, Helicoverpa zea, than the untreated area immediately surrounding the treated area, and 25% fewer H. virescens and 19% fewer H. zea than the control area. There was a 41% total overall reduction in emergence in cages placed over plots in treated areas compared to similar cages over untreated plots. Although these results indicated much less effect than in the previous year's test where the overall reductions had been 88 to 95%, bioassay data of host plant terminals in the 1990 test showed that only 12% as much virus was deposited on the target host plants when compared to a 1989 application tests. The lack of adequate coverage of the virus on target alternate hosts was also indicated by the numbers of spray droplets recorded on water-sensitive cards placed randomly in target areas. These data indicated 93% less droplets compared to the previous test. Virus persistence on alternate host plants compared favorably with previous studies in that virus activity was 47% of the original activity at 9 days after application. These data indicate that virus application and coverage was a major problem. Although the treatment failed to reduce the adult populations as much as in previous experiments, the results were encouraging in that the the number of moths emerging was still significantly reduced, even when NPV coverage was poor. Timing was less a factor than spray coverage, but the 21-day application period in this test would be considered too long in most seasons. Additional, or larger, aircraft may be needed to to obtain proper coverage and reduce the application period. (M. R. Bell, D. D. Hardee, J. L. Hayes)

Several new strains of the bacterium, Bacillus thuringiensis, and 3 baculoviruses were bioassayed for their activity and potency against the tobacco budworm, Heliothis virescens. A cage study was conducted using one of the strains of the bacterium to determine its effectiveness in reducing emergence of Heliothis from early season hosts. Results of the test were encouraging compared to previous tests with the bacterium.

Previous cage studies had shown only approximately a 50% reduction in the numbers of moths emerging after treatment, whereas a 73% reduction was obtained in this test. (M. R. Bell)

Planned cooperative formulation research towards developing improved application formulations was not undertaken during 1990 due to lack of sufficient time for the project. (M. R. Bell and W. P. Scott)

A laboratory study was conducted from mid-June through mid-September to estimate the feeding rate of field-collected Chrysopa carnea larvae on nymphs of the black-margined yellow pecan aphid, Monellia caryella. Results showed that Chrysopa larvae consumed an average of about 10 aphid nymphs/day throughout the larval stage. Chrysopa pupae were also collected throughout the course of the 3-month study. Parasitism of the field-collected pupae was near 80%. Identification of the parasites is pending. (V. R. Calcote)

Late season cover crops were planted in June in order to attract pea aphids or other aphids that would result in a build-up of pecan aphid predators. Hairy indigo, browntop millet, and velvetbean were planted in strips in pecan orchards at seven locations within a 20-mile radius of Stoneville. Rainfall was low during this period and a sufficient stand failed to germinate at two locations. However, no aphids developed at the locations where growth was adequate; therefore there was no build-up of beneficial predators. Yellow aphids in the pecan trees were in sufficient numbers to cause some sooty mold. (V. R. Calcote)

In order to find pecan varieties adaptable to this area, six acres of seedlings were planted in 1984 and grafted to 37 selections in 1987. These trees were evaluated for yield, insect and disease resistance, and retention of foliage this season. An additional six acres planted in 1987 were grafted to 37 selections (different from the first planting) in April 1990. (V. R. Calcote)

Three pheromone trap designs were tested for relative effectiveness in monitoring populations of hickory shuckworm [Cydia caryana (Fitch)] moths. The traps consisted of two plastic bucket-type traps of differing color configurations and one wing-style sticky trap. Each treatment (i.e., trap design/color) was replicated four times in each of six different orchards within a 20-mile radius of Stoneville. Traps were emptied and male moths counted twice/week; traps were rotated at their respective locations once/week. Traps were placed in test orchards in mid-August and monitored through mid-October. Total numbers of male moths caught were as follows: wing-style trap: 168 moths; green/yellow/white bucket trap: 148 moths; all-green bucket trap: 68 moths. (V. R. Calcote, D. E. Hendricks)

The spittlebug, Clastoptera obtusa (Say), on pecan was monitored throughout the season to determine the extent of nut loss caused by the insect. Nut clusters were tagged and the number of nuts and the number of spittlebugs attacking the nuts in each cluster were counted during the feeding period of two generations. The number of nuts remaining in each cluster was compared to the level of infestation. The nut drop was minimal, even for the heavily infested first generation with no loss recorded for the second generation. The population threafter declined to insignificance during the remainder of the season, and the trees bore a heavy crop of nuts. (V. R. Calcote)

Tobacco budworm, Heliothis virescens (F.) larvae were collected from a pyrethroid field control failure in the Mississippi Delta in 1990. Testing with a residual plant bioassay indicated high levels of resistance to two pyrethroid insecticides and possible tolerance to a carbamate insecticide. The adult vial test method for monitoring resistance confirmed the pyrethroid resistance found in the larvae collected. The data were compared to previous results with known resistant tobacco budworms; resistance to pyrethroids was significantly higher than in 1986. (G. W. Elzen)

The temporal sequence of insecticide resistance was studied season-long in cotton in the Delta. Resistance levels were somewhat variable, but remained as high at the end of the season as at the beginning. Resistance seems to be stable within local populations. Resistance in the laboratory in isolated colonies obtained from field control failures remains stable for as long as 10 generations. Resistance to a carbamate was confirmed for the first time in tobacco budworm in the Delta. Tobacco budworm eggs from pyrethroid-resistant insects are significantly more resistant to several classes of insecticides than eggs from susceptible insects. Neonate larvae of resistant tobacco budworms are much more susceptible than 3rd instars of resistant budworms. Control should be timed at eggs and neonates. Studies with synergists indicated that metabolic resistance may be present in field populations of tobacco budworm. (G. W. Elzen)

The highest levels of resistance to pyrethroids seen to date were found in two colonies of tobacco budworm obtained from Louisiana. Resistance was confirmed through a residual plant bioassay and topical bioassays. In addition these findings have been confirmed independently by several chemical companies. High levels of resistance to a carbamate and tolerance to several organophosphates were also seen in these cultures through studies conducted at Stoneville. Multiple resistance in tobacco budworm appears to be certain in some isolated populations. (G. W. Elzen, B. Leonard, J. B. Graves)

Nine treatments were evaluated for control of tarnished plant bug adults using a laboratory spray chamber. Percent mortality was significantly higher for all insecticide treatments compared to a water-treated control. Guthion gave the lowest numerical percent control. At equivalent rates (0.5 lb AI/a), treatment with Curacron or Lorsban gave 100 percent control. (G. W. Elzen, G. L. Snodgrass)

Six treatments were evaluated as ovicides for control of Heliothis virescens in a replicated trial in cotton. All treatments produced significantly better control than an untreated check. Total mortality was significantly greater with the organophosphates, Bolstar and Curacron, than with a carbamate, a pyrethroid, or a formamidine. Treatment with ovicides may be a valuable strategy when faced with populations of insecticide-resistant tobacco budworms. (G. W. Elzen)

Fifteen treatments were applied for control of tobacco budworm and bollworm in replicated plots in cotton. All insecticide treatments significantly reduced the number of damaged squares below that observed in the control. All treatments significantly reduced the number of tobacco budworm/bollworm eggs and live larvae below the number observed in the control. Significantly fewer larvae were found in the Larvin plus Ovasyn treatment than in the other treatments. (G. W. Elzen)

Fourteen treatments of Bacillus thuringiensis and ovicides were evaluated for toxicity to tobacco budworm using a laboratory spray table. The addition of other materials to Dipel did not increase mortality obtained with Dipel alone. The Dipel plus Ovasyn treatment showed significantly less mortality than the Dipel alone. Ovasyn, Bolstar, Larvin, and Curacron, at the low rates alone, were less effective than Dipel at the larval rate alone. (G. W. Elzen)

Seven treatments to determine the efficacy of synthetic pyrethroids in combination with organophosphates were evaluated for control of pyrethroid resistant tobacco budworms using a laboratory spray table. Reduced rates of Baythroid combined with a reduced rate of Bolstar was as effective as a full rate of Bolstar. No synergism was observed. (G. W. Elzen)

Twenty-three treatments (two trials) were tested for relative efficacy against cotton aphid in nonirrigated cotton. Efficacy of treatments was evaluated by counting aphids within one square inch on the upper surface of a leaf in the top third, middle third, and bottom third portion of 40 randomly selected plants/treatment. Aphid counts were made over a period of 12 days (trial 1) or three days post-treatment (trial 2). In trial 1, Capture, methyl Thiodan, and Lorsban [1.0 lb (AI)/a] were generally more effective than other treatments except the untreated check. In trial 2, urea, Asana, and Baythroid were less effective than other treatments except an untreated check. (G. W. Elzen)

Six different replicated tests with alarm pheromones for cotton aphids, Aphis gossypii Glover, showed no reduction in number of aphids due to their application. Multiple formulations from two private companies failed to show any positive results. Additional tests will be performed in 1991. (D. D. Hardee, M. Ainsworth)

Studies of the effect of six treatments at planting on seasonal development of OP resistance in aphids revealed that (1) aphid populations peaked during the week of July 16, (2) a fungal epizootic and the parasite, Lysiphlebus testaceipes, began decreasing aphid numbers during the week of July 23, (3) aldicarb (0.75 lb AI/a in-furrow at planting, and 0.75 lb AI/a at planting and sidedress on July 12) were the most effective treatments, (4) aphids developing in plots treated with furadan and orthene were the most resistant, and (5) aphids from all treated plots were more resistant to laboratory sprays than a "resistant" colony reared since 1988. (D. D. Hardee, W. P. Scott, M. Ainsworth)

The Stoneville Research Quarantine Facility (SRQF) received fifteen shipments of exotic insect material in 1990. Two of the shipments were in support of research on the diamondback moth, Plutella xylostella, from Malaysia and the Philippines. Several of the shipments were of Anaphes sp. (S.g. Patasson sp.), a Lygus sp. egg parasite, from France. Two Heliothis sp. parasitoids were also received. Cotesia kazak, a larval parasitoid was received from New Zealand and Pterocormus promissorius (Erich.), a pupal parasitoid was received from Australia. Four of the shipments were received in support of the Helicoverpa zea sterile hybrid project. Heliocheilus albipunctella, H. fletcheri, pallida, and assulta were received from Mali, Hawaii, and Zimbabwe, respectively. All of these shipments were used for the crossing trials with H. zea. There were twenty-eight shipments released to cooperators from the SRQF in 1990. Monthly meetings were held in the quarantine facility on quarantine affairs; reports were distributed to quarantine and regulatory personnel on the state and federal level. An annual report of all the SRQF activities for 1989 was compiled and distributed. (W. W. Harrison)

Glyptapanteles herbertii, the exotic velvetbean caterpillar larval parasitoid, was released in soybeans in Blackville, SC. No further laboratory studies were done. (W. W. Harrison)

The committee on Kudzu Management: Limiting the Spread and Reclaiming Lands, met twice (Stoneville, MS and Auburn, AL). The committee finished the first draft on a project proposal to be submitted for possible Regional Project status. The SRQF submitted the section on biological control. Project goals are to develop and implement long-term management strategies and useful approaches for the purpose of limiting the further

spread of kudzu and for reclaiming infested lands. The research approach that the SRQF will be directly responsible for will be the importation and basic research of exotic natural enemies of kudzu. (W. W. Harrison)

Initial research has begun in SRQF on Erthmocerus californicus Howard, a pupal parasitoid of the sweetpotato whitefly, Bemisia tabaci (Gennadius). (W. W. Harrison)

Insect production for USDA-ARS research in 1990 required maintenance of eight insect species: Helicoverpa zea, Heliothis virescens, Anticarsia gemmatalis, Pseudoplusia includens, Galleria mellonella, Spodoptera exigua, Cardiochiles nigriceps, and Microplitis croceipes. Research by USDA-ARS scientists at Stoneville and laboratories in Beltsville,MD; Gainesville, FL; Columbia, MO; College Station, TX; Mississippi State, MS; and Weslaco, TX required production of 507,000 H. virescens pupae; 338,000 H. zea pupae; 101,000 A. gemmatalis pupae; 237,000 P. includens pupae; 156,000 S. exigua pupae; 72,696,000 H. virescens eggs; 46,980,000 H. zea eggs; 8,130,000 A. gemmatalis eggs; 23,760,000 P. includens eggs; 13,170,000 S. exigua eggs; 294,495 M. croceipes cocoons; 32,950 C. nigriceps cocoons and 26,000 G. mellonella larvae. Additional research support required mixing, dispensing, and filling of 219,773 30-ml plastic cups and 1,002 3.8 liter multicellular trays with artificial insect diet. Total diet mixed and dispensed in 1990 was 19,672 liters. (G. G. Hartley)

Participation in the Cotton Foundation TBW-BW Distribution Program in 1990 remained consistent with previous years with sixty researchers located in 21 states and England receiving insects. Participants were supplied with 1,352,000 eggs and 67,050 pupae of the tobacco budworm and bollworm. Income of $38,609.54 was derived after 20% administrative cost was deducted. These funds were used to purchase insect rearing supplies and pay temporary labor. Participation in this program is expected to remain at the same level in 1991. (G. G. Hartley)

Multicellular rearing methods for Pseudoplusia includens, Anticarsia gemmatalis, and Spodoptera exigua were fully implemented. Development and implementation of this technology allowed for expansion of the American Soybean Association's Insect Distribution Program to support entomological research on soybeans. It also represents considerable savings in labor and materials that were required for previous rearing methods. (G. G. Hartley)

A remote electronic system was developed for automatically detecting and counting numbers of boll weevils responding to grandlure in Leggett-type weevil traps. Accuracy of this system was greater than 90% when tested in laboratory and initial tests outdoors. Each weevil detector unit installed in the field consumes only about 4 mW of power from a 6-volt lantern battery, and one battery will last for about 1 year. When a weevil is detected, a radio telemetry signal is transmitted to a base receiver and computer, which collates the number of weevils detected at hourly intervals throughout the day. Technical plans, reprints, and schematic diagrams of automated insect detection systems were supplied to several ARS cooperators and agricultural consultant companies and suppliers. (D. E. Hendricks)

Field experiments were run in Mississippi and Texas to compare performance and persistence of baits made from polyvinyl chloride (PVC) that contained 7.5 mg of the major pheromone components Z-11-hexadecenal (Z11-16AL) and Z9-tetradecenal (Z9-14AL) in a 15:1 ratio, with or without 0.018 mg of Z-11-hexadecen-1-ol (Z11-16:OL). Capture of tobacco budworm moths (TBW) in inverted-cone traps was used as a measure of the performance of the baits tested. Lures with Z11-16:OL added to the two major components (at a concentration of 0.25% in relation to total pheromone dosage) caught significantly more TBW males than lures without Z11-16:OL when compared for two weeks in different regions with low, medium, and high population densities. Tests with new baits run simultaneously with baits aged for 2-weeks or 4-weeks indicated that enhancement caused by Z11-16:OL diminished to insignificant levels after two weeks of use. In all tests comparing the two formulations, frequency (%) that at least one TBW was captured per trap per night was highest when lures with Z11-16:OH were used, even when the lures were six weeks old, and at low population levels. The PVC dispenser containing the 3-component mixture of pheromones has been accepted by private industry for commercial sales and use as bait in traps, and it is a candidate formulation to be used with toxicants as an attracticidal bait for tobacco budworm moths.
(D. E. Hendricks)

Experiments show that mortality in bollworm and tobacco budworm pupae can be correlated directly with the number of days that pupae remain in soil saturated with water. These are conditions that may prevail in watersheds of major drainage systems (rivers or creeks) of vast delta areas, or after a major hurricane when rainfall produces a flood condition and saturates the soil along ditchbanks or in fields used to cultivated host plants (cotton or corn) where bollworms and budworms overwinter or diapause as pupae, as in November to May. (D. E. Hendricks)

Annual surveys of Helicoverpa spp. moth populations were made using replicated installations of pheromone traps baited with appropriate pheromone baits. Moth catch data reports were sent to Dr. Barron Rector, APHIS, State Plant Pest Coordinator, for nation-wide distribution in the 1990 National Cooperative Insect Survey Report Series. Theses reports were also sent to State Agricultural Experiment Station and ARS cooperators for correlation of moth densities with various environmental parameters, and to augment development of Computer Insect Population Prediction Models such as TEXCIM at Texas A&M Univ., College Station. (D. E. Hendricks)

Collections of living Helicoverpa spp. moths were sent to Karl Narang, ARS, Fargo and (in 1989) to James Mallett, Miss. St. Univ. as biological material for studies to determine the seasonal origin of these species, if they routinely migrate, and if so, what distances. These studies involve the chemical analysis of enzymes and genetic material extracted from the moths collected, and can lead to more accurate predictability of bollworm/budworm dispersal and movement, as well as determination of their origin. (D. E. Hendricks)

Four cotton cultivars (DPL90-smooth leaved with nectaries; DPL90-smooth leaved without nectaries; STN213-pubescent leaved with nectaries; and STN213-pubescent leaved without nectaries) were evaluated in a cage (1/4 acre) for resistance to the tarnished plant bug. Tarnished plant bug adults (ca. 3,300) were released into the cage during the first week of squaring (1st week of July) and number of nymphs found on the 4 cultivars was determined on 24 and 30 July. On both of these dates pubescent STN213 without nectaries had significantly lower ($P = 0.10$ and 0.001, respectively) numbers of nymphs than the other cultivars and was the most resistant cotton based on nymphal numbers. (L. Lambert, G. L. Snodgrass, W. R. Meredith)

A study was conducted with soybean Looper to determine if genetic removal of pubescence from soybean, which reduces oviposition, coupled with foliar feeding resistance would result in a decrease in level of damage. Isolines of 'Davis', 'Tracy-M', and insect resistant line D75-1069, with dense, normal, and no pubescence were evaluated in a large field cage using laboratory-reared insects. Oviposition levels were lower on all isolines without pubescence than on ones with pubescence. Defoliation levels of the pubescence isolines were greater than of the no pubescence isolines. This indicates that an additional level of resistance may be achieved in soybean genotypes resistant to foliar feeding insects by genetically removing plant pubescence. (L. Lambert, T. C. Kilen)

An evaluation of twelve insect-resistant soybean genotypes with different maturity dates was made to determine if resistance levels change during plant maturation. The studies were conducted in a large field cage utilizing laboratory-reared insects. It was found that all genotypes had essentially the same level of resistance prior to fruiting. After the onset of fruiting the later maturing genotypes exhibited a higher level of resistance than earlier maturing genotypes. Additional studies will be required to determine if resistance levels decrease during the fruiting phase or if later maturing genotypes develop higher levels of resistance. (L. Lambert, E. E. Hartwig)

Studies were conducted to determine the virulence of a recently identified insect virus against four foliar feeding insect species which damage soybean. The virus was found to be highly active against tobacco budworm, bollworm, and soybean looper. The activity level was very low against velvetbean caterpillar. In a field cage study it was found that application of the virus to plants with five-day-old soybean looper larvae resulted in a high level of larval infection. However, due to the slow rate at which the virus eliminated the larvae, damage levels to plants was not reduced. (L. Lambert, M. R. Bell, J. Solomon)

Field studies were conducted to determine the influence of drought stress on the suitability of insect susceptible and insect resistant soybean as a host for soybean looper. Soybean looper adults were introduced into small field cages which had been placed over irrigated and non-irrigated plants. More eggs were deposited on non-irrigated plants than on irrigated plants. However, after five days fewer larvae were found on non-irrigated plants than on irrigated plants. Additionally, defoliation levels after ten days was significantly lower on non-irrigated plants than on irrigated plants. The indication of this research is that insect control measures may be reduced or not required on drought stressed plants since insect populations are lower and will develop more slowly. (L. Lambert, L. G. Heatherly)

A study was conducted to determine if the presence or absence of soybean plant pubescence influences the ability of Microplitis croceipes to locate and successfully parasitize bollworm larvae. Isolines of the cultivar Tracy-M with dense, normal, and no pubescence were grown in a large field cage. Bollworm adults were introduced into the cage where they oviposited on plants and a larval population developed. M. croceipes adults were then introduced into the cage where they parasitized the larvae. Preliminary data analysis indicates that no significant differences in levels of parasitization occurred between larvae on any of the pubescence types. Thus, if the glabrous character is used as an insect resistance factor in soybean it will not reduce the efficacy of this parasite against bollworm. (L. Lambert, J. E. Powell)

In field cage evaluations of 600 accessions from the USDA-ARS soybean germplasm collection, three genotypes were identified with high levels of resistance to foliar feeding by soybean looper. These accessions will be further evaluated and used in a breeding effort to develop soybean cultivars with high levels of resistance to insects. (L. Lambert, T. C. Kilen)

Studies were conducted in small field cages with several cotton genotypes to determine the influence of nectar and plant pubescence on oviposition levels of tobacco budworm. Plants without nectaries and without pubescence received fewer tobacco budworm eggs than plants with pubescence and with nectaries. These results indicate that the genetic removal of plant nectaries and pubescence may reduce naturally occurring tobacco budworm populations in cotton fields. (L. Lambert, W. R. Meredith)

Research on the tobacco budworm hybrid has included maintenance of two advanced backcross colonies, currently in the 192nd and 55th generations. The sterile male trait has persisted in these colonies. Problems were encountered with the Heliothis subflexa collected in 1989 and the laboratory colony was lost. Larvae were again collected in 1990 and efforts are being made to establish a laboratory colony from these larvae. (M. L. Laster)

Efforts to develop a Helicoverpa zea sterile hybrid were continued in 1990. Mating trials between H. zea and Helicoverpa punctigera from Australia have resulted in no progeny. Helicoverpa pallida (10 larvae) from Nihoa, Hawaii were imported into the Stoneville Research Quarantine Facility (SRQF) but a laboratory colony was not established. Helicoverpa fletcheri from Mali, West Africa and Helicoverpa assulta were recently imported into the SRQF. Establishment of laboratory colonies from these importations will be attempted. (M. L. Laster)

Heliothis pupal handling and placement methods for improved moth emergence in wide-area release programs were continued in 1990. Treatments consisted of: (1) harvested pupae placed in trays with vermiculite and plant material; (2) pupae in form-filled trays with top removed and stacked in styrofoam box; and (3) pupae in form-filled trays with top removed and stacked in standard cardboard box. Each treatment consisted of a known number of pupae (ca. 1,000) with eight replications in a randomized complete block design. Percent emergence for the three treatments was: (1) 84.4, (2) 96.0, and (3) 95.0. Emergence of 84.4% from the harvested pupae was greater than the 59.2% for the same treatment obtained the previous year, but was still significantly lower than the emergence for the other two treatments. (M. L. Laster, J. L. Roberson, E. A. Stadelbacher)

The distribution of sterile backcross moths, from a control release point was studied during the H. virescens overwintering emergence period of 1990. Pheromone traps were distributed in locations at distances of 0.4 mi to 3.3 miles from the release point. Of 18,485 backcross moths (marked internally with red dye) released from the central point, 3% were recaptured. The released moths distributed well throughout the trapping area. The greatest number of released moths captured per trap per night (1.83) was captured within 0.5 mile of the release point. Distances in 0.5 mile increments from the release point showed the second highest recapture rate (1.05/trap/night) occurred between 2.0 and 2.5 miles from the release point. (M. L. Laster, D. D. Hardee)

Tobacco budworm populations were monitored during 1990 using wire cone traps. The number of moths caught in individual traps was highly variable due to trap location. The traps were effective in identifying the initiation and increase of the July tobacco budworm population in cotton. There was a lag time of 4 days between the initial increase of moths captured in the traps and the time control measures were required in the cotton. Population trends as indicated by trap capture data were less defined as the season progressed, generations overlapped, and control measures became more intense. (M. L. Laster, D. D. Hardee)

Studies on water absorption by tarnished plant bug eggs were completed. Data on the rate of absorption over time and its effect on subsequent hatch is being used to develop a bioassay for testing the effects of various chemicals on egg hatch. (J. M. McWilliams, G. L. Snodgrass)

Studies were conducted to determine the effect on parasitoids of insecticides commonly used in cotton. Recommended rates of compounds were applied using the spray table. Four developmental stages of the parasitoid were treated: parasitoid egg, early instar parasitoid, and late instar parasitoid within the host; and parasitoid pupa within its cocoon. The tobacco budworm was used as the host species and for unparasitized checks. Microplitis croceipes, M. demolitor, and Cotesia kazak were treated with Larvin at two rates (0.25 lb [AI]/acre, 0.6 lb [AI]/acre). M. croceipes was treated with Guthion (0.25 lb [AI]/acre), Vydate (0.25 lb [AI]/acre), Asana XL (0.03 lb [AI]/acre), and methyl parathion (0.25 lb [AI]/acre). Each test consisted of four 32-cell trays of parasitized larvae (one for each of four stages) to be sprayed, four trays of parasitized larvae to be unsprayed, four trays of unparasitized tobacco budworm larvae to be sprayed, and four trays of unparasitized tobacco budworm larvae to be unsprayed. Each 32-cell tray contained one tobacco budworm larva per cell. When the desired developmental stage of parasitized larvae was reached, the tray was sprayed along with a tray of unparasitized larvae. Each test was replicated four times

(except twice for Larvin), yielding a total of 64 trays or 2,048 insects per parasitoid species per compound. Cocoons apparently protected parasitoids from insecticide materials; survival was near 100% for many of the tests even when survival of other stages was nearly 0%. Eggs or early instars of the parasitoids were more susceptible than were late instars. Survival in unparasitized tobacco budworm that were sprayed was greater than for parasitized larvae. (J. E. Powell, M. L. Laster)

Adults of imported parasitoids were released along roadsides near Elizabeth, MS. 6,260 M. demolitor and 5,541 C. kazak were released between 30 May and 03 August 1990. Those areas will be checked in the spring of 1991 to determine if the species survived the summer and overwintered. On 30 April 1990, 305 tobacco budworm larvae parasitized by Microplitis demolitor were released in wild host plants, including geranium, on Australia Island. On May 10, 14, and 18, tobacco budworm larvae were placed in cotton adjacent to the parasitoid release site. M. demolitor was recovered from the cotton, along with indigenous parasitoids C. marginiventris, Cardiochiles nigriceps, and a tachinid. Although numbers were low (n=41), parasitism rates averaged 44%. (J. E. Powell, M. L. Laster)

Release of H. zea from pupae placed in soybean in emergence boxes was conducted in July 1990. The first test was conducted in soybean in 1989. Emergence in 1990 from 5 boxes each containing 26-30 trays (32 cells each) averaged 95%. When considering the numbers of originally empty cells and abnormal larvae/pupae that were eliminated before trays were placed in the field, the actual emergence from total potential of one healthy insect per cell was 73%. Results were similar to that obtained in 1989 (99% emergence of those in box, 87% emergence from potential of one insect per cell). (J. E. Powell, L. Lambert, J. L. Roberson)

Dispersal of M. croceipes was recorded after release of adults in cotton. 971 adults were released July 17, 1200 were released July 22, and 1,710 were released July 30. Collections of adults were made for two or three days subsequent to releases. Even one day after release, wasps were located at least 122 meters away in various directions, but primarily north even though prevailing winds seemed negligible. (J. E. Powell, J. L. Roberson)

Field cage studies were conducted in cotton to ascertain parasitization rates at different parasitoid-host ratios. Densities of tobacco budworm larvae and parasitoids were varied and replicated. Test periods were 24 and 48h. Cages (6 x 6 x 12 ft) made of fine mesh screen were placed over two rows of cotton which were artificially infested with 80 early instar tobacco budworm per cage. After 24h, female parasitoids were placed in cages at rates of 0, 2, 4, 6, 8, or

10 per cage; each test included two cages per parasitoid density. The entire test was replicated four times. Preliminary studies were conducted to determine numbers of hosts and parasitoids to use. Results showed that superparasitism was prevalent, even in cages with only two parasitoids. For example, in one test after 24h, 50% of the parasitized tobacco budworm were superparasitized (contained more than one parasitoid). After 48h, one larva contained 13 parasitoids. Parasitism rates were determined by dissection. Trend analyses are being conducted to extrapolate numbers needed for release to effect high levels of parasitism. (J. E. Powell)

The Insect Rearing Research Unit (IRRU) maintained colonies of Anthonomus grandis grandis, Heliothis virescens, Heliocoverpa zea, and Microplitis croceipes for service support and mass rearing research assignments. Service support for insect production was utilized as follows: 1) Boll Weevil - Production of test material (eggs, larvae, adults, diet) for assessment of sterility procedures, insecticide screening, parasite production, and cancer research. 2) Heliothis virescens - production of test specimens for genetic sterility, pathogenic bioassay, and parasite rearing research. 3) Heliocoverpa zea - production to evaluate acute larval irradiation and adult infestations in field plots to assess insect resistance of plant strains. 4) Microplitis croceipes - production to test improved mass rearing processes and provide specimens for field tests. Diet prepared for colony maintenance and research projects totaled 11,645 liters for boll weevil, 3,079 liters for bollworm/budworm, and 649 liters for other location research scientists. Four thousand nine hundred boll weevil rearing trays (2,450,000 weevils) were shipped to 23 National Cotton Foundation research recipients. (J. L. Roberson, O. L. Malone, and D. K. Harsh)

Engineering and procedure modifications installed/adapted to improve rearing technologies and equipment operations at the IRRU are listed as follows: 1) Reroute diet transfer lines from diet preparation to tray forming rooms by mounting into wall brackets; 2) Install steam outlets in diet transfer tubing to permit longer steam cleaning periods and avoid damage to diet dispensing equipment; 3) Established operational status of the Kutter tray forming unit with vacuum function; 4) Constructed a mechanical adapter to Kutter tray forming unit to enable quick adjustment of tray depth (3 inches or less); 5) Designed and tested three parasite sting cages to reduce labor requirements; 6) Reviewed egg treatment process and introduced modifications for use with fumehood and increased monitoring of quality control for egg processing and tray assembly, and 7) Reorganized boll weevil pellet equipment to reduce labor and space requirements. (J. L. Roberson, O. L. Malone, and D. K. Harsh)

The IRRU increased technology transfer activities by hosting an IAEA Fellowship Program through the National Research Council, and worked with two USDA, APHIS Methods Development Laboratories to adapt production of their rearing programs to the mechanized tray preparation process practiced at the IRRU. Dr. Mohammed A. J. Al-Izzi (Baghdad, Iraq) was awarded a five-month fellowship to study mechanized mass rearing techniques in the United States. During this period, he conducted concurrent studies in his Baghdad laboratory and the IRRU to rear pomegranate fruit moth in disposable boll weevil rearing trays. (J. L. Roberson)

Spray table tests were conducted to determine the effects of one rate of insecticide applied in 1, 3, 6, and 12 gallons of total volume per acre. Results indicate that higher mortality occurred using the 3- and 6-gallon volumes. The results of these tests were to be evaluated further in a large field plot experiment, but due to extremely low natural infestations, no data were obtained on field populations. (W. P. Scott, A. R. Womac)

Second and 3rd-instar bollworm larvae were exposed to synthetic oils (orchex, sunoil, Isopar, Aromatic), crop oil (Bettakill) and the invert emulsion without insecticide. The rates were equivalent to 2 and 3 gallons of total volume per acre. A laboratory strain of susceptible larvae had a higher mortality than a laboratory colony of resistant larvae when exposed to the oils. The highest mortality occurring in the resistant group was with Aromatic (7.5%). The highest mortality with the susceptible larvae occurred with Orchex (12.5%), Bettakill (17.5%) and Aromatic (15%). (W. P. Scott, A. R. Womac)

Aldicarb was applied in-furrow and as a sidedress application or both to determine the effects of various rates on the suppression of aphids and spider mites. In general, all aldicarb rates suppressed aphids and mite populations throughout the summer. In most instances, added benefits were gained with the sidedress application over the in-furrow only treatment of aldicarb when aphid and mite counts were made. Extremely dry weather during the testing period caused plant stress. Large numbers of small green bolls were shed in late July and August. Higher yields were obtained in all aldicarb treatments compared to the foliar. Treatment effects did not necessarily fall out in the yield data. (W. P. Scott)

No progress was made in determining residual activity of insecticides on cotton leaves utilizing gas chromatography. (W. P. Scott, J. E. Mulrooney)

Spray tests were made to determine the effects of various oils and insecticides on bollworm mortality. Rates below recommended field rates were applied to determine the effects of various oils in combination with Capture. Resistant larvae were exposed to the synthetic oils (Orchex, Sunoil, Isopar, and Aromatic) and crop oils (Bettakill) plus .05 lb AI/acre of Capture. The highest mortality occurred with the Bettakill (67%), Sunoil (60%), and Orchex (55%). When susceptible bollworm larvae were exposed to the same oils with lower rates of Capture (.02 lb AI/acre), 100% mortality was obtained with Bettakill and Orchex. (W. P. Scott, A. R. Womac, J. E. Mulrooney)

Several hundred tarnished plant bug nymphs collected in May and June from wild host plants in an undisturbed area of Washington County, Mississippi were reared to determine if they were parasitized by Leiophron schusteri or Peristenus nigricarpus. Adults of these 2 braconid wasps had been released in the area during May 1987. None of the plant bug nymphs collected were parasitized. (G. L. Snodgrass)

A survey to determine the species of egg parasites of the tarnished plant bug in the Mississippi Delta was continued in 1990. Host plant material containing plant bug eggs was collected at monthly intervals at one location near a cotton field in Washington Country. The material was held in boxes and the parasites that emerged were identified. Collections were made from 12 plant species begining in April and ending in November. One egg parasite species, Anaphes iole Girault, was found in very low numbers. (G. L. Snodgrass)

Nymphs of the tarnished plant bug were sampled with a sweep net (38 cm diam.) and drop cloth (1.0 X 0.9 m) in cotton (all fields were DES119) at 3 locations in Washington County, Mississippi during 1990. Sampling was begun during the first week prior to squaring and continued at weekly intervals for the next 6 weeks. Known nymphal populations were created by placing nymphs on marked plants. Sampling was begun approximately 1 hour after the nymphs were released. At all 3 locations nymphal size (2nd and 4th instar) and release position (square, leaf, or mainstem terminal) did not have a significant effect on sampling efficiency of the sweep net or drop cloth. The drop cloth captured significantly higher numbers of nymphs in most weeks at all 3 locations than were captured with the sweep net. Regression analysis was used to compare capture efficiency of the drop cloth and sweep net to average plant height using data collected from all 3 locations in 1990 and from 1 location in 1989. The regression lines for capture efficiency of the drop cloth and sweep net had equal slopes with significantly different ($P=0.02$) interceps and an R^2 value of 0.90. The predictive values of the equations were tested by sampling a cotton field that had a heavy natural infestation of plant bugs with a sweep net, drop cloth, and an absolute visual sampling method for 5 weeks begining with the

second week of squaring. Equal numbers of samples were taken with each method and each sample was from 15 cm of row. Numbers captured with the sweep net and drop cloth were corrected by use of the regression equation and compared to numbers captured in the absolute sampling method. For the drop cloth the corrected number captured during the 5 weeks of the test was estimated to be 305, while 264 (87% of the corrected number) were captured in the absolute samples. Corrected numbers of nymphs captured with the sweep net totaled only 98 (37% of the number captured in the absolute samples). These results indicate that the drop cloth is superior to the sweep net for sampling nymphs, and that fairly accurate estimates can be made of the actual number of nymphs present in a field by sampling with a drop cloth and correcting sample numbers with the regression equation developed in the tests. (G. L. Snodgrass)

Resistance levels to the organophosphorus insecticides, dimethoate and acephate, were again determined in 1990 in adult plant bugs collected from 5 locations in the Mississippi Delta and from 2 non-Delta locations. Data analysis and comparison of results to previous studies done at the locations in 1987 and 1988 are incomplete. (G. L. Snodgrass)

A canola (rape seed) field located at Leland, Mississippi was sampled during April and May 1990 for tarnished plant bugs. The overwintered adults that moved into the field produced 1 generation in the field before the crop matured in late May. These F_2 adults were then available to move into cotton during June. Population levels averaged as high as 11 adults and nymphs per 20 sweeps with a 38-cm (diameter) sweep net. (G. L. Snodgrass)

In the spring of 1990, a research project was initiated to investigate genetic variability in oviposition preference within and among populations of the cotton bollworm, Helicoverpa zea, originating from different geographical areas of the U.S. Specific objectives were to characterize and compare oviposition preferences of the different populations and to determine heritabilities of oviposition preference within each population. In addition, genetic correlations between oviposition preference and other important traits influencing fitness, such as fecundity and body size, were to be estimated. Finally, the genetic basis of differences in oviposition preferences between populations was to be explored using crossing experiments. A decision was made to use sibling analysis to estimate genetic variability in oviposition preference within bollworm populations. Mating and rearing procedures compatible with sibling analysis were developed during the spring and summer using bollworms from the USDA-ARS colony at Stoneville (in culture five years). Wild bollworms from corn were obtained from Weslaco, TX (early summer, from R. Coleman, USDA-ARS), Stoneville, MS (mid-late summer), and

Clayton County, NC (last summer, from J. R. Bradley, N.C. State University). Three colonies were started using 15 to 45 mated females from each locality. Preliminary work was conducted during the summer involving primarily the development of an oviposition preference test. The test developed involves flying individual moths in small screen cages containing flowering terminals of host material. A decision was made to use glabrous and pubescent isolines of Stoneville 213 cotton and Tracy-M soybeans as test plants. A nested half-sib experimental design was developed in which each colony would be tested twice for a total of approximately 200 moths (20 families) per colony. The first test from this experiment was run in October 1990, using moths from the Weslaco, TX colony. There was no significant variability in oviposition preferences among families tested; within family variability was very high. It should be remembered, however, that this test represents only 1/6 of the entire experiment. If the data are analyzed strictly from a preference standpoint, there is a definite preference hierarchy. Proportions of eggs laid on hairy cotton are significantly higher than those laid on other hosts, while there are no differences between hairy soybean and glabrous cotton, and glabrous soybean is distinctly nonpreferred. In addition, sibling analysis is being used to investigate genetic variability in body size and developmental time of bollworms. Of major interest is a comparison of the USDA colony (in culture 5 years) with the relatively feral insects used in the work mentioned above. Preliminary results are inconclusive. (K. E. Ward, J. L. Hayes, D. D. Hardee)

Different nozzles were evaluated to determine the spray pattern with various carriers. Utilizing the malvern, data indicated that all spray nozzles available generated a wide range of droplet sizes. (A. R. Womac, W. P. Scott)

2. Extramural

Flight responses of the parasitoid, Microplitis croceipes Cresson, to two phenological stages of spring hosts (crimson clover, Trifolium incarnatum L., hairy vetch, Vicia villosa Corbiere, and cutleaf geranium, Geranium dissectum (L.) and summer host plants (cotton, Gossypium hirsutum L., sorghum, Sorghum bicolor L., and soybean Glycine max L.) of Heliothis virescens (F.), were measured in a dual choice situation in a wind tunnel. Preflowering clover was more attractive than preflowering geranium, followed by preflowering vetch. Clover was preferred over geranium in flowering stages as well. No within species differences were detected for the two phenological stages. Preflowering and flowering cotton and soybean were preferred over preflowering and flowering sorghum. (J. P. Kaas, G. W. Elzen, S. B. Ramaswamy)

Microplitis croceipes females were observed between 0600-2000 hours in cages containing spring host plants infested with Heliothis virescens, tobacco budworm (TBW) larvae. Cages contained Geranium dissectum, cutleaf geranium, and Trifolium incarnatum, crimson clover, in equal plantings, each of which was infested with 50 TBW larvae. The periodicity of various behaviors exhibited by the wasps on the two host plants were recorded and a behavioral time budget was constructed. M. croceipes females spent the most time standing still, followed by searching, preening, oriented flight, general flight, and walking. The proportion of time spent preening increased over the day. Oriented flight, general flight, searching, and walking peaked in the morning between 0900 and 1200 hours. Oriented flight, general flight, and walking showed minor increases in the afternoon. Although M. croceipes females did not show significant differences in the amount of time spent sitting or preening on geranium versus clover, significantly more time was spent walking and searching on clover than on geranium. The wasps spent significantly more time in orienting towards clover than to geranium. On the host plant surface, wasps spent relatively more time standing still on geranium than on clover and more time walking and searching on clover than on geranium. No significant differences in relative time spent preening was found. (J. P. Kaas, G. W. Elzen, S. B. Ramaswamy)

Sensory receptors on the antennae, labial and maxillary palpi, and foretarsi of Microplitis croceipes (Cresson) were examined by scanning electron microscopy. The occurrence of antennal sensilla not described by earlier workers is reported. Generally, there are 6 types of sensilla in adults of M. croceipes, namely, sensilla (s.) trichodea, s. basiconica, s. chaetica, s. placodea, s. campaniformia and s. coeloconica. Sensilla placodea, campaniformia and coeloconica occur only on antennal flagella. However, s. trichodea and s. basiconica were present on all structural parts examined. Variants of s. trichodea (Trichodea A, B, C and D) and those of s. basiconica (Basiconica A and B) are described. The present paper documents for the first time the occurrence of Trichodea B, C and D, Basiconica B, s. chaetica, s. campaniformia and s. coeloconica in M. croceipes. Sexual dimorphism in M. croceipes correlated with antennal sensilla type; s. campaniformia are present only on female antennae whereas s. coeloconica and bent-tipped trichoid sensilla (D) occur only on male antennae. Other sensilla types occur in both sexes. (R. C. Navasero, G. W. Elzen)

The effect of maternal age and host [Heliothis virescens (F.)] deprivation on egg production and allocation by Microplitis croceipes (Cresson) was determined in the laboratory on 0.5, 1.0, 3.0, 6.0, 9.0, and 12.0-day-old parasitoids. In host-deprived parasitoids, newly-emerged (0.5-day old) females produced significantly fewer eggs than older ones; egg

production peaked 3 to 6 days after emergence and declined thereafter. However, the number of eggs found in undeprived parasitoids at various ages suggested a cyclical pattern of egg production. The rate of parasitization by host-deprived M. croceipes was higher in 1.0 to 6.0 day old than in newly-emerged or older females and was correlated strongly with egg production (r=0.93). The first observation on premature larval hatching in M. croceipes was documented. (R. C. Navasero, G. W. Elzen)

B. Indicators of Progress

1. Publications (Published, In Press, Accepted)

Bell, M. R. 1990. Aerial application of a nuclear polyhedrosis virus for reducing the emergence of Heliothis from early-season hosts. Proc. Beltwide Cotton Prod. Conf., pp. 273-274.

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Snodgrass, G. L. Resistance levels in the tarnished plant bug (Heteroptera: Miridae) to acephate and dimethoate in the Mississippi Delta. (In preparation).

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3. Presentations

Bell, M. R. "Aerial application of a nuclear polyhedrosis virus for reducing the emergence of Heliothis from early-season hosts." Beltwide Cotton Prod. Conf., Las Vegas, NV, January 1990.

Bell, M. R. "Development of microbials for use in insect pest management systems." Regional Research Project S-135, Orlando, FL, February 1990.

Bell, M. R. "Use of baculovirus for the control of Heliothis spp. in area-wide pest management programs." Invitational presentation at the international meeting, Vth International Colloquium on Invertebrate Pathology and Microbial Control Adelaide, Australia, August 1990.

Bell, M. R. "Management of bollworm/budworm populations through area wide application of nuclear polyhedrosis virus on early-season alternate hosts." 37th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1990.

Calcote, V. R., and W. L. Tedders. "Trichogramma pretiosum tested as a biological control agent against the hickory shuckworm." Pecan Arthropod Regional Project, Helen, GA, July 1990.

Elzen, G. W. "Ovicide research update." Mid-South Cotton Seminar (sponsored by Rhone Poulenc Ag Co.), Natchez, MS, January 1990. (Invitation)

Elzen, G. W. "Microplitis host searching behavior." USDA-ARS, Research Planning Meeting, Tifton, GA, January 1990.

Elzen, G. W., F. A. Harris, and M. R. Reid. "Determination of pyrethroid resistance in field populations of Heliothis virescens." Beltwide Cotton Prod. Res. Conf., Las Vegas, NV, January 1990.

Elzen, G. W. "Heliothis control with non-pyrethroids." Miss. Agricultural Consultants Association, 17th Annual Meeting, Greenwood, MS, February 1990. (Invitation)

Elzen, G. W. "Determination of pyrethroid resistance in a field population of tobacco budworm." Rhone-Poulence Ag Co., Research Triangle Park, NC, February 1990. (Invitation)

Elzen, G. W. "Aphid resistance and problems." Ciba-Geigy, Greenville, MS, March 20, 1990. (Invitation)

Elzen, G. W. "Insecticide resistance in tobacco budworm." Resistance Management Strategy Meeting, Ciba-Geigy Corp., Stoneville, MS, October 1990. (Invitation)

Elzen, G. W. "Insecticide resistance in tobacco budworm." Mobay Cotton Pest Management Seminar, Baton Rouge, LA, November 1990. (Invitation)

Elzen, G. W. "Further evaluation of Heliothis resistance." 37th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1990. (Invitation)

Elzen, G. W. "Characteristics of insecticide resistance in a tobacco budworm population recently collected from cotton." National ESA Meeting, New Orleans, LA, December 1990.

Hardee, D. D. "Cotton aphids: Current status and future trends in management." Beltwide Cotton Prod. Conf., Las Vegas, NV, January 1990. (Invitation).

Hardee, D. D. "Cotton insect management: Aphids." 17th Annual Delta Ag Expo, Cleveland, MS, January 1990. (Invitation).

Hardee, D. D. "Update on aphid problems." Rhone-Poulenc Mid-South Cotton Seminar, Natchez, MS, January 1990. (Invitation).

Hardee, D. D. "Cotton aphid research and control." 17th Annual Meeting, Miss. Agric. Cons. Assoc., Greenwood, MS, February 1990. (Invitation).

Hardee, D. D. "Update on cotton aphid research and control." Rhone-Poulenc Ag Co., Research Triangle Park, NC, February 1990. (Invitation).

Hardee, D. D. "Status and future use of the Stoneville Research Quarantine Facility." Annual Meeting S-238, Southern Regional Biological Control Project, Orlando, FL, April 1990. (Invitation).

Hardee, D. D. "Management of cotton bollworm/tobacco budworm populations through area-wide application of nuclear polyhedrosis virus on early-season alternate hosts." Soviet/American Symposium on Cotton IPM, Tashkent, Uzbekistan, USSR, September 1990. (Invitation).

Hardee, D. D. "Cotton insect problems in the U.S. - an overview." Soviet/American Symposium on Cotton IPM, Tashkent, Uzbekistan, USSR, September 1990. (Invitation).

Hardee, D. D. "Major problems with minor insects." FMC Cotton Consultant Conference, Orlando, FL, October 1990. (Invitation).

Hardee, D. D. "Non-insecticidal approaches to pest management in cotton - are we making any progress?" 37th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1990. (Invitation).

Hayes, J. L. "Relating Heliothis spp. pheromone trap captures to egg counts in cotton: Data from the Delta of Mississippi." Beltwide Cotton Prod. Res. Conf., Las Vegas, NV, January 1990.

Hayes, J. L. "Dynamics of nocturnal behavior of adult Heliothis spp. in cotton in the Mississippi Delta." Dept. of Entomology, Michigan State University, East Lansing, MI, January 1990. (Invitation).

Hayes, J. L. "Use of rubidium labelling to examine movement of tarnished plant bugs among early season wild hosts." Southeastern Branch Meeting of ESA, Orlando, FL, February 1990.

Hendricks, D. E. "Performance of pheromone formulated with or without Z-11-hexadecen-1-ol in PVC bait for trapping tobacco budworm moths. 37th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1990.

Hendricks, D. E., T. N. Shaver, and R. F. Albach. "Longevity and relative performance of pheromone with or without Z-11-hexadecen-1-ol in PVC as bait for trapping Heliothis virescens." Beltwide Cotton Prod. Conf., Las Vegas, NV, January 1990.

Hendricks, D. E. "Development of sodar and photosensitive systems used in field surveys to detect insects attracted to sex pheromone baits and to transfer incident information to a computer." International Advanced Robotics Programme, Workshop on Robotics in Agriculture and the Food Industry, Paper No. 1311, Avignon, France, June 1990. (11 pages and 6 figures contributed).

Lambert, Lavone, and Larry Heatherly. "Reduced Soil Water Potential Causes Induced Insect Resistance in Soybean". Annual Meeting, Southern Branch of American Society of Agronomy, Little Rock, AR, February 1990.

Lambert, Lavone. "Response of Heliothis zea to Feeding on various plant parts used to indicate the resistance potential of 'Lamar' soybean." Southeastern Branch Meeting of ESA, Orlando, FL, February 1990.

Lambert, Lavone. "Status of Host Plant Resistance to Insects in Soybean." Soybean Looper Insecticide Resistance Workshop, Orange Beach, AL, March 1990. (Invitation)

Lambert, Lavone. "USDA-ARS Soybean Hostplant Resistance to Insects Research Program". University of Tennessee, Knoxville, TN, April 1990. (Invitation)

Lambert, Lavone, and Larry Heatherly. "Influence of Drought Stress on Suitability of Soybean as a Host for Soybean Looper." 37th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1990. (Invitation)

Laster, M. L. "Heliothis pupal handling and placement methods for improved moth emergence in wide-area release programs." Beltwide Cotton Prod. Conf., Las Vegas, NV, January 1990.

Laster, M. L. "Use of pheromone traps in bollworm/tobacco budworm management in cotton." 37th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1990.

Navasero, R. C., and G. W. Elzen. "Sensory receptors on the antennae, foretarsi, and palpi of Microplitis croceipes." National ESA Meeting, New Orleans, LA, December 1990.

Powell, J. E., and W. P. Scott. "Survival of Microplitis croceipes (Cresson) in contact with residues of insecticides in cotton." Beltwide Cotton Prod. Conf., Las Vegas, NV, January 1990.

Powell, J. E. "Efficacy of Microplitis in cotton." Meeting, Development of an Applied Package for Biocontrol of Heliothis spp. with Microplitis croceipes, Tifton, GA, January 1990.

Powell, J. E. "Use of parasitoids for suppression of Heliothis." S-238 Regional Project, Orlando, FL, April 1990.

Powell, J. E. "Management of a research program." Presented to 30+ Foreign Mid-Level Managers, Stoneville, MS, August 1990.

Powell, J. E. "Insect control in cotton." Presented to 4 Soviet cotton industry officials, Stoneville, MS, September 1990.

Powell, J. E., M. L. Laster, and J. L. Roberson. "Habitat management for enhanced parasitoid efficacy." 37th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1990. (Laster made by presentation).

Scott, W. P. "A three-year study on the value of Temik and Prep in cotton production." Rhone-Poulenc Cotton Seminar, Natchez, MS, January 1990.

Scott, W. P. "Economic assessment of aldicarb." Rhone-Poulenc Cotton Seminar, Natchez, MS, January 1990.

Scott, W. P. "Managing for earliness." Rhone-Poulenc Earliness Seminar, Greenwood, MS, March 1990.

Snodgrass, G. L. "Efficiency of the drop cloth and sweep net in capturing nymphs of the tarnished plant bug in cotton." 37th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1990.

Snodgrass, G. L. "Efficiency of the drop cloth and sweep net in capturing nymphs of the tarnished plant bug in cotton." Southeastern Branch Meeting of ESA, Orange Beach, AL, March 1990.

Ward, K. E. "Quantitative genetics of oviposition preference in Helicoverpa zea." Informal seminar, U.S. Forest Service, Pineville, LA, July 1990.

4. Other Reports

Bell, M. R. Two news releases were prepared in cooperation with ARS Information Office, an article was prepared entitled "Budworms and Bollworms Targeted by a Virus" and published in October 1990 "Agricultural Research" magazine, plus other news releases were organized through local media.

Hendricks, D. E. "Electronic Insect Detection, Selective and Highly Accurate," Cotton Grower Magazine, Meister Publ. Co., Memphis, TN, May 1990 issue.

Hendricks, D. E. "Semiochemicals Workshop." Submitted report of on-going and planned research, Atlanta, GA, May 1990.

Laster, M. L., and E. A. Stadelbacher. "Confined upbringing won't detract from sex appeal, scientists say." Release to ARS Information Staff, August 1990.

IV. Planned Research for Calendar Year 1991

A. Narrative

1. In-House

A second year of the pilot test will be conducted to determine the effectiveness of Baculovirus heliothis in reducing the emergence of tobacco budworm and cotton bollworm moths from early season hosts. The insect virus will be applied aerially to all weeds within a 100-square-mile test area, and the effect on the first seasonal generation of Heliothis/Helicoverpa will be evaluated by a team of entomologists. Within this study, the coverage and persistence of the virus will be evaluated, and the effect on adult emergence will be determined through cage studies within the test area. Cooperative studies will be done with other scientists to evaluate properly this control method as an area-wide management tool for Heliothis management in the Mississippi Delta. Changes will be made in the program compared to the Spring 1990 test in order to improve application coverage. (M. R. Bell)

Laboratory bioassays of possible new or more active insect pathogens against major row crop pests will continue. (M. R. Bell)

Cooperative laboratory and greenhouse studies will continue toward the development of a practical feeding-stimulant formulation for use in controlling both boll weevils and Heliothis/Helicoverpa in this area. Although few microbial insecticides are promising for use against weevils, the bait formulation will also be evaluated in its ability to increase the effectiveness of chemical insecticides. (M. R. Bell, W. P. Scott)

Cooperative laboratory, greenhouse, and field studies will be conducted to determine the effectiveness of several nuclear polyhedrosis viruses in controlling lepidopteran pests of soybeans primarily the soybean looper. (M. R. Bell, L. Lambert)

Studies of the nature of insecticide resistance in tobacco budworm will be continued. Resistance to non-pyrethroids was confirmed in 1989-90 (by GWE). Studies with an array of synergists applied to various life stages will further elucidate the mechanisms of resistance; cross- or multiple-resistance will be confirmed. Behavioral resistance and the mechanisms of resistance in the egg stage will be studied. Studies of the inheritance of insecticide resistance, and consequent implications for pest management, have been planned. Biologicals for control of multiple-resistant tobacco budworms will be intensively studied. (G. W. Elzen)

The spray table and replicated field trials will be used to evaluate newly registered biologicals, alone and in combination with ovicides, new formulations or newly registered insecticides, and synergists. (G. W. Elzen)

The spray table residual plant bioassay will be used to evaluate insecticide resistance in field populations of tobacco budworm in Louisiana and Mississippi. Topical bioassays on Louisiana populations will be performed in cooperation with LSU researchers (Graves, Leonard, Burris); topical bioassays on Mississippi populations will be performed at Stoneville. The two methods will give a clear picture of resistance levels in natural populations. (G. W. Elzen)

A study of the influence of systemic insecticides applied at planting on cotton aphid resistance will be continued. Supporting laboratory and greenhouse tests will be conducted. Additional evaluations will be made of various alarm pheromones for cotton aphids. Three methods of sampling for cotton aphids will be compared to determine the most reliable method. (D. D. Hardee, M. Ainsworth)

A study will be conducted to determine if cotton resistant to pest insects has an effect on parasitoids of the bollworm and tobacco budworm. Plants will be grown in the greenhouse and tested by placing parasitized larvae on caged plants. (D. D. Hardee, J. E. Powell, M. L. Laster)

SRQF will continue to receive and evaluate exotic natural enemies which will be reared through at least one generation, identified and released to cooperators or held for quarantine study in the SRQF. Importations will be documented and voucher specimens maintained. An annual report of quarantine activity will be generated and distributed. (W. W. Harrison)

We will continue to receive and document exotic Heliothis/Helicoverpa in support of the bollworm sterile hybrid project. Protocol and safe handling of pest species in the Maximum Security Area of the quarantine laboratory will be maintained. Monthly meetings will be conducted and reports compiled and disseminated to quarantine and regulatory officials on the state and national level. Voucher specimens will be preserved and representative numbers will continue to be shipped to state and national museums. (W. W. Harrison)

Work with the committee on Kudzu Management: Limiting the Spread and Reclaiming Lands will continue. Plans are to hire a person to manage committee activities and reports and continue efforts for Regional Project status. (W. W. Harrison, D. D. Hardee)

Developmental responses of Eretmocerus californicus Howard (Hymenoptera: Encyrtidae) on Bemisia tabaci (Gennadius) and (Homoptera: Aleyrodidae) reared on different host plants will be evaluated. The developmental responses of E. californicus on B. tabaci reared on four different host plants (cotton, tomato, soybean, and cucumber) in the quarantine greenhouse will be evaluated. This study is partly in preparation for that to be done later with exotic sweetpotato whitefly parasitoids received in SRQF. (W. W. Harrison)

Studies planned with Helicoverpa zea pupal parasitoid, Pterocormus promissorius include host range and developmental times of the cotton bollworm exotic pupal parasitoid, P. promissorius (Erich.) (Hymenoptera: Ichneumonidae). (W. W. Harrison)

The insect distribution programs with the Cotton Foundation and the American Soybean Association will continue in 1991. The Cotton Foundation program is expected to be consistent with the previous year while moderate growth is expected for the American Soybean Association Program. Funds provided by these programs will be used to offset rearing expenses of the Southern Insect Management Laboratory. Both programs will be evaluated in 1991 to determine if a price increase for insects provided is needed to keep pace with rearing expenses. The egg and pupa/stage of the following species will be available: tobacco budworm, bollworm, beet armyworm, soybean looper, velvetbean caterpillar, Microplitis croceipes (cocoon only). (G. G. Hartley)

The insect rearing research support group at Stoneville will maintain eight insect species in 1991. These are tobacco budworm, bollworm, soybean looper, beet armyworm, velvetbean caterpillar, greater wax moth, Cardiochiles nigriceps, and Microplitis croceipes. Also, insecticide resistant strains of several species will be maintained to assist individual scientists. Artificial insect diet will be supplied in a 30 ml plastic cups and 3.8 liter multicellular trays. Continued efforts will be made to produce high quality diets at economical prices, improve rearing procedures, and develop better insect scale collection systems. The research of over 100 scientists within USDA-ARS, private industry, and state universities will be supported by the work of this unit. (G. G. Hartley)

The seasonal preferences of Helicoverpa spp. for host plants will be studied and determination of their dependency on wild plant hosts that serve as sources reservoirs for winter and early season populations will be made. (D. E. Hendricks)

Research will be coordinated to determine the origin of dispersing Helicoverpa spp. populations by genetic characterization of DNA and isoenzyme loci found in unique populations throughout the southern U.S., in cooperation with many State and ARS entomologists. (D. E. Hendricks)

Field bioassays will be made of formulations of bioactive materials including attractants, disruptants, or attracticides affecting mortality or the mating behavior of insect pests (bollworm/budworm) of cotton and other agronomic and wild host plants. (D. E. Hendricks)

Techniques will be developed to optimize sampling, trapping, characterizing, and predicting seasonal densities, and studying effects of various Helicoverpa control projects; species may include tobacco budworm, bollworm, cotton fleahopper, and lygus bugs. (D. E. Hendricks)

Systems to detect automatically pest insects responding to pheromone baits will be field tested to compare results with typical insect behavior patterns related to host selection, oviposition, flight periodicity. We will provide expertise and advice to coordinate the implementation of automated insect detection system by other researchers and agricultural consultants. (D. E. Hendricks)

Survival mechanisms associated with bollworm and tobacco budworm pupation process and pupae mortality will be studied, and these mechanisms will be correlated with soil environment parameters found in typical agronomic conditions. (D. E. Hendricks)

Studies will be conducted to determine if the genetic removal of soybean plant pubescence enhances the resistance levels of soybean genotypes with foliar feeding resistance to all species of foliar feeding insects. (L. Lambert, T. C. Kilen)

The study to determine the influence of soybean plant maturity on insect resistance will be expanded to determine if resistance levels decrease during the fruiting phase or if it increases to a higher level in late maturing genotypes. (L. Lambert, E. E. Hartwig)

Studies will be conducted to determine if a practical method can be developed for using an insect virus to control soybean damaging insects. (L. Lambert, M. R. Bell, J. Solomon)

Research will be continued to determine the impact of drought stressed soybean on all foliar feeding insect species. (L. Lambert, L. G. Heatherly)

Studies with be expanded to determine the impact of the removal of soybean plant pubescence on the ability of predators and parasites to locate their prey successfully. (L. Lambert, J. E. Powell)

Evaluations of the USDA-ARS soybean germplasm collection will continue in an effort to identify resistance to all species of soybean damaging insects. (L. Lambert, T. C. Kilen)

Studies will continue to determine the influence of insect resistance characters of cotton on populations of insects common to soybeans and cotton. (L. Lambert, W. R. Meredith)

Field studies will be conducted to determine the impact of insect-resistant soybean cultivars on insect populations under production conditions. (L. Lambert, G. L. Snodgrass)

A mark-release-recapture study will be conducted with the sterile backcross in the Australia Island - Eagle lake area of the lower Mississippi delta. Approximately 20,000 marked backcross moths will be released per day over the six week period of the tobacco budworm overwintered emergence. The moths will be released and trapped in a grid configuration. Data gathered from this study will be used to determine the overwintered population of the tobacco budworm. These data will, in turn, be used as a basis for a suppression release program in 1992. Final results should determine the feasibility of suppressing tobacco budworm populations by releasing the sterile backcross. (M. L. Laster, D. D. Hardee)

Efforts to develop an Helicoverpa zea sterile hybrid will be continued. Crossing studies will be initiated with H. zea and the exotic species H. assulta and H. fletcheri as sufficient numbers become available. Efforts to obtain other exotic species for crossing studies will be continued. (M. L. Laster)

Laboratory studies will be continued with M. demolitor, M. croceipes, and C. kazak using the following hosts: Heliothis virescens, H. subflexa, and sterile hybrid backcross in early and advanced generations (1-4, 50, and +190) to determine preference, development, and longevity of parasitoids. Sex ratio of F_1 generation will be observed. (M. L. Laster, J. E. Powell)

Strips of sesame and pigeonpea will be planted in a cotton field, infested with tobacco budworm larvae, and used as a field insectary for parasitoids. Parasitism in the field will be monitored to determine movement and efficacy of wasps. This study will be done in conjunction with early-season releases in geranium to suppress the population that moves into cotton. (J. E. Powell, M. L. Laster, J. L. Roberson)

Tobacco budworm and bollworm larvae will be collected in the deltas of Mississippi and Arkansas to determine if imported parasitoids have become established. (J. E. Powell, M. L. Laster)

Large numbers of Pterocormus promissorius, an ichneumonid pupal parasitoid from Australia, will be released on Australia Island in the spring and in September. This species is easy to rear and may be adaptable to large-scale rearing procedures. (J. E. Powell, M. L. Laster, J. L. Roberson, W. W. Harrison)

We will conduct spray table tests to determine effects of insecticides on C. nigriceps, and continue ongoing studies with M. demolitor, M. croceipes, and C. kazak. (J. E. Powell, M. L. Laster)

The IRRU will continue maintenance colonies of Anthonomus grandis grandis, Heliothis virescens, Helicoverpa zea, and Microplitis croceipes for mass rearing research and production service. Shipments of boll weevil to scientists are expected to maintain current levels during CY 91. We are also shipping tray forms upon request of other federal laboratories desiring to adapt production of their test species to the disposable trays. The disposable trays can be produced at this laboratory with considerable cost savings when compared to purchasing from commercial sources. We plan to continue cooperative work with the USDA, APHIS Methods Development Laboratories for establishment of compatible mechanized rearing equipment between the working groups. (J. L. Roberson, O. L. Malone, D. K. Harsh)

Mass rearing research for Microplitis croceipes at the IRRU will focus on adapting rearing processes developed to expanded production. In CY 90, it was necessary to concentrate attention on egg treatment and handling procedures. Major problems were experienced with biased sex ratios and bacterial contamination. We have implemented major changes in egg treatment, larval tray assembly, and stinging operations to reduce microbial contaminant levels and labor requirements. We are currently in the process of reviewing other handling operations to improve cocoon production efficiency using the tote box rearing process. (J. L. Roberson, O. L. Malone, D. K. Harsh)

The IRRU anticipates production obligations of 20,000 Heliothis virescens backcross pupae per day for a six-week period in support of M. Laster's proposed 1991 Heliothis backcross release program. The IRRU will receive eggs from the Stoneville rearing unit, implant the eggs in disposable trays, then package trays for delivery to the field. Tentative plans have also been discussed for production of parasites for field studies that will be used by J. Powell. (J. L. Roberson, O. L. Malone, and D. K. Harsh)

Different rates of aldicarb applied as an in-furrow treatment, as a sidedress treatment and/or both will be further evaluated for aphid and spider mite suppression. Different methods of applying aldicarb on sidedress will be studied. (W. P. Scott)

Studies will be conducted by utilizing gas chromatography to determine residual activity of various insecticides on plant parts. Known quantities of insecticides will be placed on leaf surface. At different time intervals, leaves will be washed to determine amount of residue present on leaf surface. (W. P. Scott, J. E. Mulrooney)

Drift and spray deposit associated with the Hardi Sprayer, conventional sprayer, and airplane will be evaluated. (W. P. Scott, A. R. Womac, J. E. Mulrooney)

Effects of droplet size on insect mortality and plant coverage will be studied. (W. P. Scott, A. R. Womac, J. E. Mulrooney)

The spread of synthetic and crop oils on different varieties of cotton leaves will be evaluated. (W. P. Scott, J. E. Mulrooney)

An effort will be made to obtain the braconid wasp, Peristenus digoneutis, from William Day at the Beneficial Insects Introduction Research Laboratory in Newark, Delaware. This wasp is an imported parasite of nymphs of the tarnished plant bug that has become established in parts of New York and New Jersey. The wasp will be reared at Stoneville (if necessary) and released into a weedy, non-crop area located at the edge of the Mississippi Delta. If it becomes established, then its movement into and survival in the Delta will be studied. (G. L. Snodgrass)

Canola fields located in different areas of the Delta will be sampled in April and May to determine more accurately the extent that the tarnished plant bug utilizes these fields as an early-season host. This will lead to a better understanding of the potential problem that production of canola in the Delta presents to cotton production in terms of tarnished plant bug reproduction in canola followed by movement of the resulting adults from canola to cotton in June. (G. L. Snodgrass)

A survey to determine the species of egg parasites of the tarnished plant bug in the Mississippi Delta will be continued in 1991. (G. L. Snodgrass)

Development of a bioassay for determining the susceptibilitry of tarnished plant bug eggs to various chemicals will be continued. Efforts to develop an artificial diet for the tarnished plant bug will also be continued. (G. L. Snodgrass)

Experiments on sampling tarnished plant bugs in cotton will concentrate on sampling adult plant bugs. Visual and sweep net sampling will be the main sampling methods studied. (G. L. Snodgrass)

Major work planned for 1991 includes continuing the experiments initiated in 1990. Oviposition preference tests will be run approximately every 6 weeks until two tests (5-10 sires, 10-20 families per test) have been run for each colony. In addition, work will continue involving comparisons of genetic variability in body size and developmental time between feral and lab-reared bollworm colonies. If the above tests reveal important differences in oviposition preferences among populations, further oviposition preference tests using progeny of crossed individuals will be conducted to determine the genetic basis for such differences. There are still some tentative plans for conducting some quantitative genetics experiments similar to the above but involving performance traits (growth and consumption rates, food use efficiencies) of bollworm larvae. (K. E. Ward, J. L. Hayes, D. D. Hardee)

2. Extramural

None.